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(54) **METHOD AND APPARATUS FOR ENHANCING LUMEN DISPLAY IN CT SECTIONAL IMAGE OF BLOOD VESSEL, AND CT SYSTEM**

(57) The present invention discloses a method and apparatus for enhancing lumen display in a CT sectional image of a blood vessel, a computer-readable storage medium, and a CT system. The method for enhancing lumen display in a CT sectional image of a blood vessel is provided, the CT sectional image being displayed with a first window level, the method including: obtaining an average CT value $CT_{nearHeart}$ of lumen sections near the heart; obtaining a highest CT value $CT_{highest}$ of a section of a current blood vessel; determining a window level WC based on the average CT value $CT_{nearHeart}$ and the highest CT value $CT_{highest}$; and displaying at least a part of the section of the current blood vessel with the window level WC. The method, the computer-readable storage medium, the apparatus, and the CT system of the present invention allow for a window level to be preset to enhance lumen display and improve the consistency of delineating the lumen contour, thereby avoiding deviations caused by subjective selection, while saving time and improving patient flow.

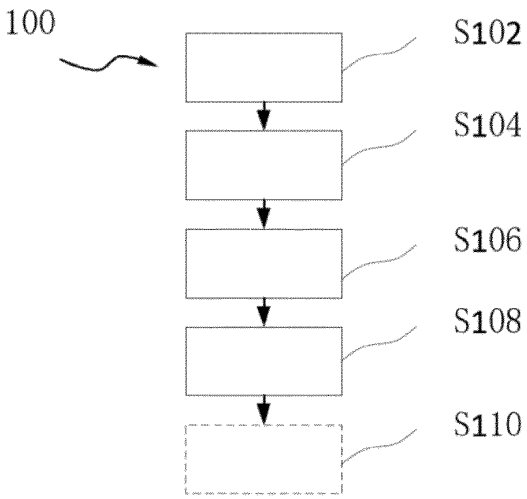

FIG. 2

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Description

Technical Field

[0001] The present invention relates to CT imaging, and in particular, to identification of a lumen of a blood vessel.

Background Art

[0002] A lumen of a blood vessel is the inside space of a tubular structure in which blood flows freely. Proper lumen delineation is critical for radiological or clinical applications and diagnosis based on CT images, which are the input for quantitative analysis or automated analysis enabled by AI models and algorithms (such as ct-FFR).

[0003] On the other hand, contrast-enhanced scans (e.g., using iodine) are often used for CT angiography due to a low contrast between the lumen and peripheral tissue, such that the HU value of the lumen is enhanced by imaging a mixture of iodine and blood.

[0004] However, in general, manual operations such as contouring from given sectional images or adjusting on axial images and MPR/CPR views remain the primary means of providing lumen contour information. Ensuring contour accuracy is challenging because:
First, CTA (CT angiography) images are usually displayed with a preset window width and window level, which may not be optimized for each specific vessel branch due to different shapes and blood volumes.

[0005] Moreover, it is difficult to determine the lumen contour when some vascular lesions (such as calcified plaques) are present near or inside the lumen. Special window settings are required to distinguish between lumen (contrast-enhanced blood volume), soft tissue, and plaques.

[0006] Therefore, deviations in the lumen contour (wider than it actually is, or including plaques that are not part of the lumen) will affect quantitative diagnostic quality. This also passes the deviations to automated or quantitative analysis (e.g., cFFR calculations). FIG. 1 is a schematic diagram of a CT sectional image of a blood vessel in the prior art, with a window width and window level optimized to distinguish between the lumen and soft tissue. A region enclosed with the pink line in the figure is the lumen, around which is soft tissue. The lumen in the figure contains plaques, but the boundary between the two is not clear. With the current window width and window level, an operator cannot distinguish between the plaques and the lumen. In order to distinguish between the plaques and the lumen, different readers adjust the window width and window level when reading the same image. Due to the difference in the window width and level, contours of blood vessels delineated may be inconsistent.

[0007] In current practice, in order to solve the above problems, a reader is required to manually adjust display settings to obtain a better visual contrast for specific regions or sections. However, there are the following limitations:

1. It is very time-consuming to manually adjust window settings for specific regions or blood vessels.

2. Full manual operation reduces reproducibility and also introduces different subjective determination deviations between readers with respect to an optimal contrast for the readers. Both of these points may affect the standardization of diagnostic or analytical quality.

3. The operation is more complex when it is necessary to distinguish between soft tissue, lumen, and plaques. Considering the two points mentioned above, it is not even feasible to frequently switch the window width and window level in the same region or section.

[0008] The Chinese invention application No. 202010893793.X discloses a medical image display method and module, and a medical imaging device, in which a medical image is displayed in a selected region with different window widths and window levels to improve a contrast of the region.

Summary of the Invention

[0009] In view of this, the present invention provides a method and apparatus for enhancing lumen display in a CT sectional image of a blood vessel, a computer-readable storage medium, and a CT system.

[0010] According to a first aspect of the present invention, a method for enhancing lumen display in a CT sectional image of a blood vessel is provided, the CT sectional image being displayed with a first window level, the method including:

obtaining an average CT value $CT_{nearHeart}$ of lumen sections near the heart;
obtaining a highest CT value $CT_{highest}$ of a section of a current blood vessel;
determining a window level WC based on the average CT value $CT_{nearHeart}$ and the highest CT value $CT_{highest}$; and

displaying at least a part of the section of the current blood vessel with the window level WC.

[0011] In one embodiment, the determining a window level WC based on the average CT value $CT_{nearHeart}$ and the highest CT value $CT_{highest}$ is determining the window level WC according to the following formula:

$$WC = \begin{cases} T, & \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right| < T \\ \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right|, & otherwise \end{cases}$$

where T is an integer and 50 < T < 200.

[0012] In one embodiment, the displaying at least a part of the section of the current blood vessel with the window level WC is superimposing a second window on a window displaying the section of the current blood vessel with the first window level, and displaying on the second window the section of the current blood vessel with the window level WC, where the same pixels of the section of the current blood vessel on the two windows overlap.

[0013] In one embodiment, the second window is movable.

[0014] In one embodiment, the second window is scalable.

[0015] In one embodiment, the method further includes displaying a curved planar reformation image of the blood vessel, where the blood vessel in the curved planar reformation image has a marker that marks a position of the section of the current blood vessel.

[0016] In one embodiment, the marker is draggable along the blood vessel, and the perimeter of the marker in the curved planar reformation image and the second window have the same window width and window level.

[0017] In one embodiment, a window width and window level of the second window for displaying the section of the current blood vessel are adjustable.

[0018] In one embodiment, the first window level distinguishes between lumen and soft tissue.

[0019] According to a second aspect of the present invention, a computer-readable storage medium is provided, where the computer-readable storage medium stores a computer program that, when run by a processor, controls a device on which the storage medium resides to perform the method described above.

[0020] According to a third aspect of the present invention, an apparatus for enhancing lumen display in a CT sectional image of a blood vessel is provided, the CT sectional image being displayed with a first window level, the apparatus including:

an average CT value obtaining unit that obtains an average CT value $CT_{nearHeart}$ of lumen sections near the heart;
a highest CT value obtaining unit that obtains a highest CT value $CT_{highest}$ of a section of a current blood vessel;
a window level determination unit that determines a window level WC based on the average CT value $CT_{nearHeart}$ and the highest CT value $CT_{highest}$; and
a display unit that displays at least a part of the section of the current blood vessel with the window level WC.

[0021] In one embodiment, the window level determination unit determines the window level WC according to the following formula:

$$WC = \begin{cases} T, & \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right| < T \\ \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right|, & otherwise \end{cases}$$

where T is an integer and 50 < T < 200.

[0022] In one embodiment, the display unit superimposes a second window on a window displaying the section of the current blood vessel with the first window level, and displays on the second window the section of the current blood vessel with the window level WC, where the same pixels of the section of the current blood vessel on the two windows overlap.

[0023] In one embodiment, the second window is movable.

[0024] In one embodiment, the second window is scalable.

[0025] In one embodiment, the apparatus further includes a curved planar reformation image display unit that displays

a curved planar reformation image of the blood vessel, where the blood vessel in the curved planar reformation image has a marker that marks a position of the section of the current blood vessel.

[0026] In one embodiment, the marker is draggable along the blood vessel, and the perimeter of the marker in the curved planar reformation image and the second window have the same window width and window level.

[0027] In one embodiment, a window width and window level of the second window for displaying the section of the current blood vessel are adjustable.

[0028] In one embodiment, the first window level distinguishes between lumen and soft tissue.

[0029] According to a fourth aspect of the present invention, a CT system is provided, the CT system including the apparatus described above.

[0030] The method, the computer-readable storage medium, the apparatus, and the CT system of the present invention allow for a window level to be preset to enhance lumen display and improve the consistency of delineating the lumen contour, thereby avoiding deviations caused by subjective selection, while saving time and improving patient flow. If the section of the blood vessel is displayed on the second window, the lumen, intraluminal abnormality, and soft tissue can be distinguished at the same time, avoiding frequent switching between two sets of window widths and window levels. This view can also be displayed in conjunction with the curved planar reformation image.

Brief Description of the Drawings

[0031] The preferred embodiments of the present invention will be described in detail hereinafter with reference to the accompanying drawings, to make the above mentioned and other features and advantages of the present invention more apparent to those of ordinary skill in the art, in which:

FIG. 1 is a schematic diagram of a CT sectional image of a blood vessel in the prior art;
FIG. 2 is a schematic flowchart of a method for enhancing lumen display in a CT sectional image of a blood vessel according to a first embodiment of the present invention;
FIG. 3 is a schematic diagram of a CT sectional image of a blood vessel according to the first embodiment and a second embodiment of the present invention;
FIG. 4 is a schematic diagram of a CT sectional image of a blood vessel according to the first embodiment and the second embodiment of the present invention;
FIG. 5 is a schematic diagram of a CT sectional image and a curved planar reformation image of a blood vessel according to the first embodiment and the second embodiment of the present invention; and
FIG. 6 is a schematic block diagram of a structure of an apparatus for enhancing lumen display in a CT sectional image of a blood vessel according to the second embodiment of the present invention.

Detailed Description of Embodiments

[0032] In order to make the objectives, technical solutions, and advantages of the present invention more apparent, the present invention will be described in further detail below by way of embodiments.

[0033] FIG. 2 is a schematic flowchart of a method 100 for enhancing lumen display in a CT sectional image of a blood vessel according to a first embodiment of the present invention. The CT sectional image is displayed with a first window level, and the method 100 for enhancing lumen display in a CT sectional image of a blood vessel includes steps S102, S104, S106, and S108.

[0034] In step S102, an average CT value $CT_{nearHeart}$ of lumen sections near the heart is obtained.

[0035] In step S104, a highest CT value $CT_{highest}$ of a section of a current blood vessel is obtained. This is because plaques have the highest CT value in this region.

[0036] In step S106, a window level WC is determined based on the average CT value $CT_{nearHeart}$ and the highest CT value $CT_{highest}$. In this embodiment, the window level WC is determined according to the following formula:

$$WC = \begin{cases} T, & \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right| < T \\ \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right|, & otherwise \end{cases}$$

where T is an integer and 50 < T < 200. Preferably, T = 100. The window width may be set to be narrower for a better contrast. A typical value of the window width is 100.

[0037] In step S108, at least a part of the section of the current blood vessel is displayed with the window level WC.

FIG. 3 is a schematic diagram of a CT sectional image of a blood vessel according to the first embodiment and a second embodiment of the present invention. FIG. 3 shows the entire section of the current blood vessel with the window level WC. On the section of the current blood vessel, the plaques and the lumen are distinguished. In a region enclosed with the pink line, the highlighted part is the plaques. In this case, the lumen contour can be delineated in the image, improving the consistency of delineating the contour by a doctor.

[0038] However, the lumen cannot be distinguished from the soft tissue in FIG. 3. To distinguish the lumen from the soft tissue, it needs to be displayed with the first window level.

[0039] In order to solve the problem of frequent switching between two sets of window widths and window levels, in step S108, a second window may be superimposed on a window displaying the section of the current blood vessel with the first window level, and the section of the current blood vessel is displayed on the second window with the window level WC, where the same pixels of the section of the current blood vessel on the two windows overlap. FIG. 4 is a schematic diagram of a CT sectional image of a blood vessel according to the first embodiment and the second embodiment of the present invention. As shown in FIG. 4, a square region is the second window, in which the lumen and the plaques are distinguished by the window level WC; and outside the second window, the lumen and the soft tissue are distinguished by the first window level. Therefore, an operator can distinguish between lumen, soft tissue, and plaques at the same time.

[0040] Preferably, the second window is movable.

[0041] Preferably, the second window is scalable.

[0042] Preferably, a window width and window level of the second window for displaying the section of the current blood vessel are adjustable.

[0043] In addition to displaying at least a part of the section of the current blood vessel (on the second window) with the window level WC, in this embodiment, the method 100 further includes step S110. In step S 110, a curved planar reformation image of the blood vessel is displayed, where the blood vessel in the curved planar reformation image has a marker that marks a position of the section of the current blood vessel. FIG. 5 is a schematic diagram of a CT sectional image and a curved planar reformation image of a blood vessel according to the first embodiment and the second embodiment of the present invention. The lower two figures in FIG. 5 are curved planar reformation images. As shown in FIG. 5, a blood vessel in the curved planar reformation image has a yellow line marking a position of a section of the current blood vessel. In this embodiment, the marker is draggable along the blood vessel, and the section of the blood vessel on the second window is also updated synchronously. The perimeter of the marker in the curved planar reformation image has the same window width and window level as the second window, and the perimeter may be, for example, a square region centered on the yellow line.

[0044] The present invention further provides a computer-readable storage medium. The computer-readable storage medium stores a computer program that, when run by a processor, controls a device on which the storage medium resides to perform the method 100.

[0045] FIG. 6 is a schematic block diagram of a structure of an apparatus 200 for enhancing lumen display in a CT sectional image of a blood vessel according to the second embodiment of the present invention. The CT sectional image is displayed with a first window level, and the apparatus 200 for enhancing lumen display in a CT sectional image of a blood vessel includes an average CT value obtaining unit 202, a highest CT value obtaining unit 204, a window level determination unit 206, and a display unit 208.

[0046] The average CT value obtaining unit 202 obtains an average CT value $CT_{nearHeart}$ of lumen sections near the heart.

[0047] The highest CT value obtaining unit 204 obtains a highest CT value $CT_{highest}$ of a section of a current blood vessel. This is because plaques have the highest CT value in this region.

[0048] The window level determination unit 206 determines a window level WC based on the average CT value $CT_{nearHeart}$ and the highest CT value $CT_{highest}$. In this embodiment, the window level WC is determined according to the following formula:

$$WC = \begin{cases} T, & \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right| < T \\ \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right|, & otherwise \end{cases}$$

where T is an integer and 50 < T < 200. Preferably, T = 100. The window width may be set to be narrower for a better contrast. A typical value of the window width is 100.

[0049] The display unit 208 displays at least a part of the section of the current blood vessel with the window level WC. FIG. 3 is a schematic diagram of a CT sectional image of a blood vessel according to the first embodiment and a

second embodiment of the present invention. FIG. 3 shows the entire section of the current blood vessel with the window level WC. On the section of the current blood vessel, the plaques and the lumen are distinguished. In a region enclosed with the pink line, the highlighted part is the plaques. In this case, the lumen contour can be delineated in the image, improving the consistency of delineating the contour by a doctor.

[0050] However, the lumen cannot be distinguished from the soft tissue in FIG. 3. To distinguish the lumen from the soft tissue, it needs to be displayed with the first window level.

[0051] In order to solve the problem of frequent switching between two sets of window widths and window levels, in this embodiment, the display unit 208 superimposes a second window on a window displaying the section of the current blood vessel with the first window level, and displays on the second window the section of the current blood vessel with the window level WC, where the same pixels of the section of the current blood vessel on the two windows overlap. FIG. 4 is a schematic diagram of a CT sectional image of a blood vessel according to the first embodiment and the second embodiment of the present invention. As shown in FIG. 4, a square region is the second window, in which the lumen and the plaques are distinguished by the window level WC; and outside the second window, the lumen and the soft tissue are distinguished by the first window level. Therefore, an operator can distinguish between lumen, soft tissue, and plaques at the same time.

[0052] Preferably, the second window is movable.

[0053] Preferably, the second window is scalable.

[0054] Preferably, a window width and window level of the second window for displaying the section of the current blood vessel are adjustable.

[0055] In addition to displaying at least a part of the section of the current blood vessel (on the second window) with the window level WC, in this embodiment, the apparatus 200 further includes a curved planar reformation image display unit 210 that displays a curved planar reformation image of the blood vessel, where the blood vessel in the curved planar reformation image has a marker that marks a position of the section of the current blood vessel. FIG. 5 is a schematic diagram of a CT sectional image and a curved planar reformation image of a blood vessel according to the first embodiment and the second embodiment of the present invention. The lower two figures in FIG. 5 are curved planar reformation images. As shown in FIG. 5, a blood vessel in the curved planar reformation image has a yellow line marking a position of a section of the current blood vessel. In this embodiment, the marker is draggable along the blood vessel, and the section of the blood vessel on the second window is also updated synchronously. The perimeter of the marker in the curved planar reformation image has the same window width and window level as the second window, and the perimeter may be, for example, a square region centered on the yellow line.

[0056] The present invention further provides a CT system, including the apparatus 200.

[0057] The method, the computer-readable storage medium, the apparatus, and the CT system of the present invention allow for a window level to be preset to enhance lumen display and improve the consistency of delineating the lumen contour, thereby avoiding deviations caused by subjective selection, while saving time and improving patient flow. If the section of the blood vessel is displayed on the second window, the lumen, intraluminal abnormality, and soft tissue can be distinguished at the same time, avoiding frequent switching between two sets of window widths and window levels. This view can also be displayed in conjunction with the curved planar reformation image.

[0058] The above descriptions are merely preferred embodiments of the present invention, but not intended to limit the present invention. Any modifications, equivalent substitutions, improvements, etc. made within the spirit and principle of the present invention should be included within the scope of protection of the present invention.

Claims

1. A method for enhancing lumen display in a CT sectional image of a blood vessel, the CT sectional image being displayed with a first window level, the method comprising:

   obtaining an average CT value $CT_{nearHeart}$ of lumen sections near the heart;
   obtaining a highest CT value $CT_{highest}$ of a section of a current blood vessel;
   determining a window level WC based on the average CT value $CT_{nearHeart}$ and the highest CT value $CT_{highest}$; and
   displaying at least a part of the section of the current blood vessel with the window level WC.

2. The method according to claim 1, wherein the determining a window level WC based on the average CT value $CT_{nearHeart}$ and the highest CT value $CT_{highest}$ is determining the window level WC according to the following formula:

$$WC = \begin{cases} T, & \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right| < T \\ \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right|, & otherwise \end{cases}$$

wherein T is an integer and 50 < T < 200.

3. The method according to claim 1, wherein the displaying at least a part of the section of the current blood vessel with the window level WC is superimposing a second window on a window displaying the section of the current blood vessel with the first window level, and displaying on the second window the section of the current blood vessel with the window level WC, wherein the same pixels of the section of the current blood vessel on the two windows overlap.

4. The method according to claim 3, wherein the second window is movable.

5. The method according to claim 3, wherein the second window is scalable.

6. The method according to claim 3, further comprising displaying a curved planar reformation image of the blood vessel, wherein the blood vessel in the curved planar reformation image has a marker that marks a position of the section of the current blood vessel.

7. The method according to claim 6, wherein the marker is draggable along the blood vessel, and the perimeter of the marker in the curved planar reformation image and the second window have the same window width and window level.

8. The method according to claim 3, wherein a window width and window level of the second window for displaying the section of the current blood vessel are adjustable.

9. The method according to claim 1, wherein the first window level distinguishes between lumen and soft tissue.

10. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program that, when run by a processor, controls a device on which the storage medium resides to perform the method according to any one of claims 1 to 9.

11. An apparatus for enhancing lumen display in a CT sectional image of a blood vessel, the CT sectional image being displayed with a first window level, the apparatus comprising:

an average CT value obtaining unit that obtains an average CT value $CT_{nearHeart}$ of lumen sections near the heart;
a highest CT value obtaining unit that obtains a highest CT value $CT_{highest}$ of a section of a current blood vessel;
a window level determination unit that determines a window level WC based on the average CT value $CT_{nearHeart}$ and the highest CT value $CT_{highest}$; and
a display unit that displays at least a part of the section of the current blood vessel with the window level WC.

12. The apparatus according to claim 11, wherein the window level determination unit determines the window level WC according to the following formula:

$$WC = \begin{cases} T, & \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right| < T \\ \frac{1}{2}\left|CT_{highest} - CT_{nearHeart}\right|, & otherwise \end{cases}$$

wherein T is an integer and 50 < T < 200.

13. The apparatus according to claim 11, wherein the display unit superimposes a second window on a window displaying the section of the current blood vessel with the first window level, and displays on the second window the section

of the current blood vessel with the window level WC, wherein the same pixels of the section of the current blood vessel on the two windows overlap.

14. The apparatus according to claim 13, wherein the second window is movable.

15. The apparatus according to claim 13, wherein the second window is scalable.

16. The apparatus according to claim 13, further comprising a curved planar reformation image display unit that displays a curved planar reformation image of the blood vessel, wherein the blood vessel in the curved planar reformation image has a marker that marks a position of the section of the current blood vessel.

17. The apparatus according to claim 16, wherein the marker is draggable along the blood vessel, and the perimeter of the marker in the curved planar reformation image and the second window have the same window width and window level.

18. The apparatus according to claim 13, wherein a window width and window level of the second window for displaying the section of the current blood vessel are adjustable.

19. The apparatus according to claim 11, wherein the first window level distinguishes between lumen and soft tissue.

20. A CT system, comprising the apparatus according to any one of claims 11 to 19.

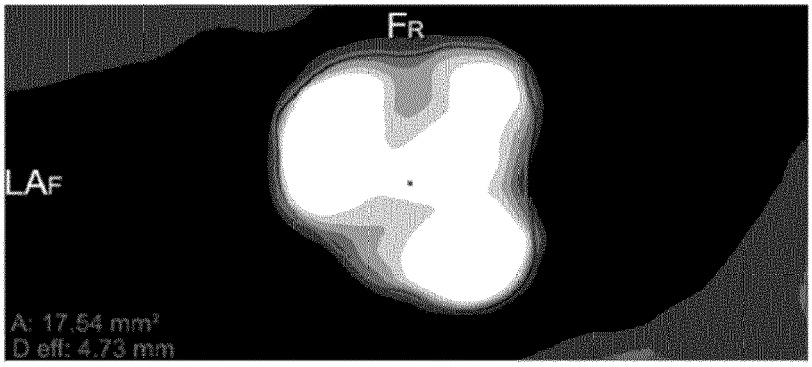

FIG. 1

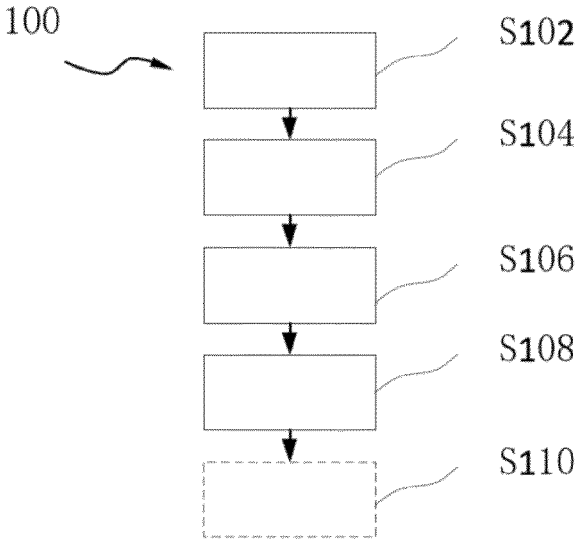

FIG. 2

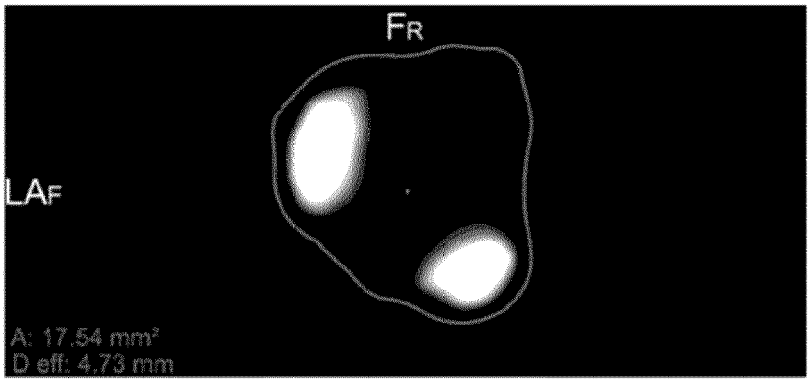

FIG. 3

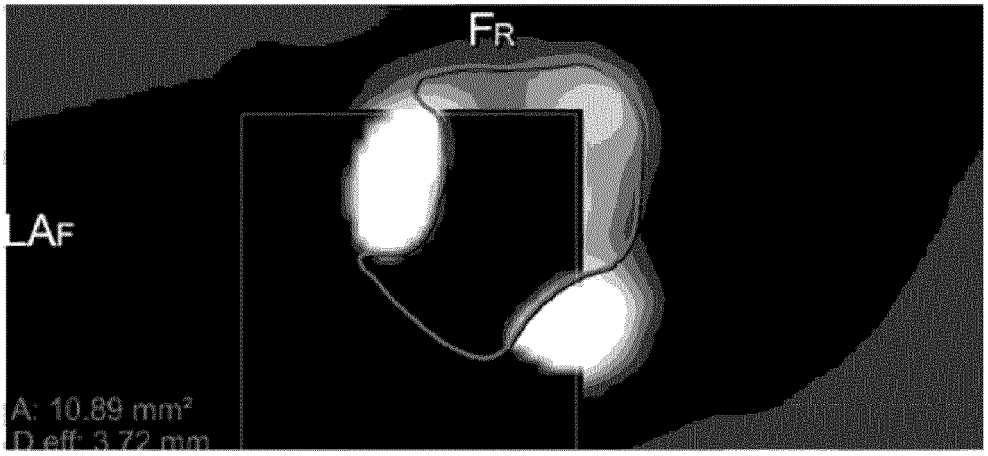

FIG. 4

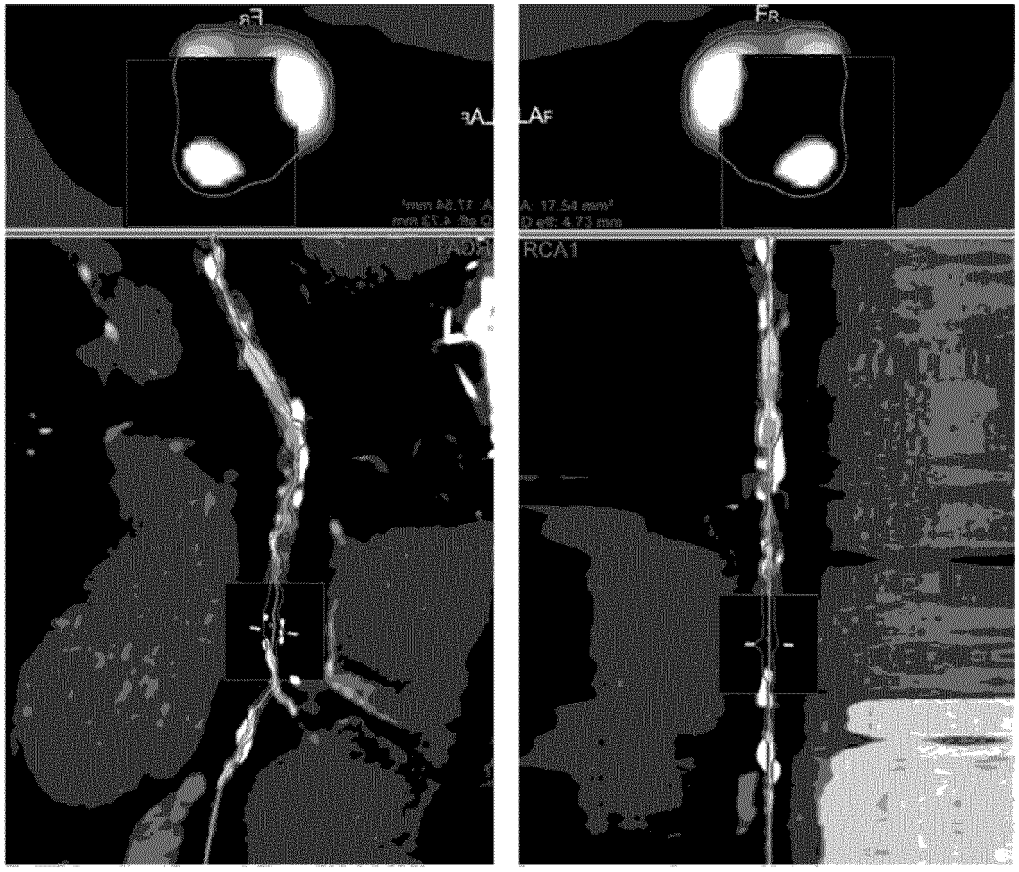

FIG. 5

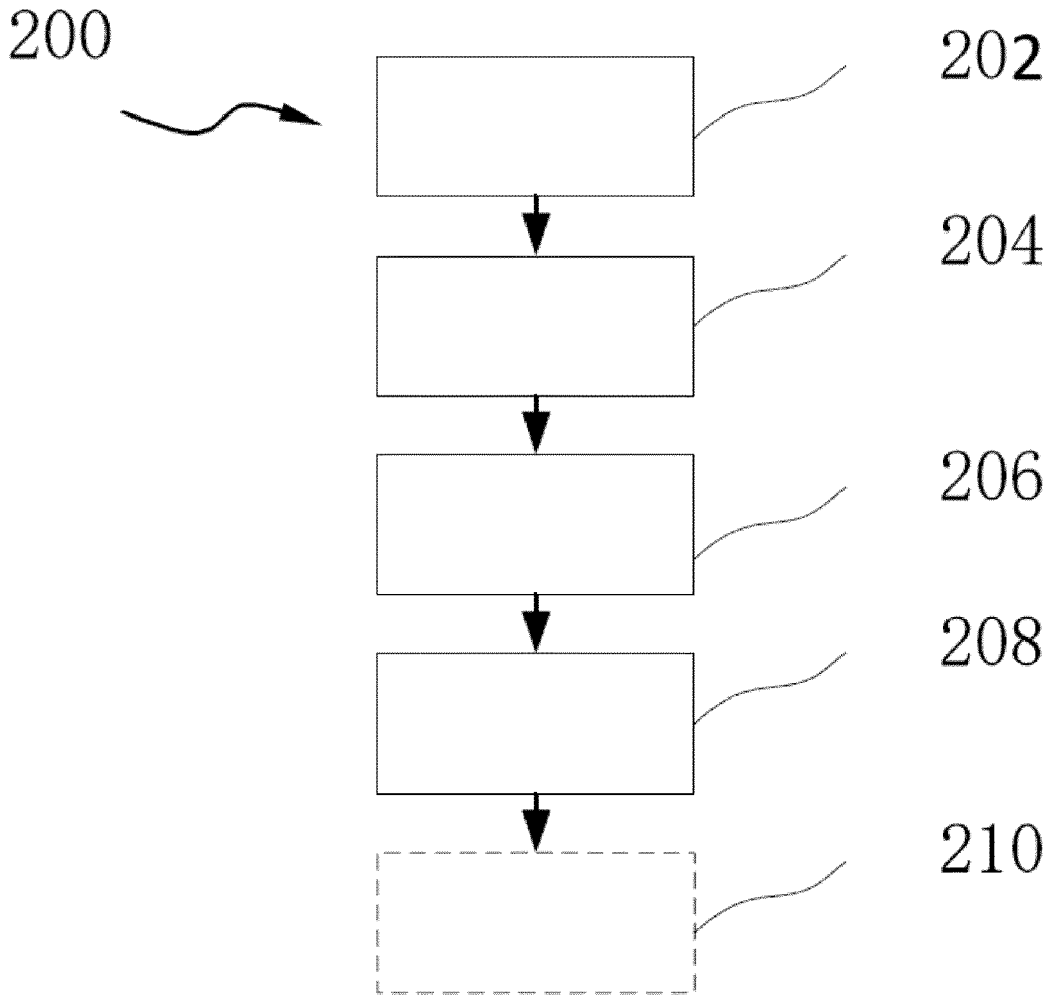

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 5800

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2010/104160 A1 (LAVI GUY [IL] ET AL) 29 April 2010 (2010-04-29) * paragraphs [0032] - [0046]; figure 3 *	1-5, 8-15, 18-20 6,7,16, 17	INV. G06T5/00 G06T19/00
Y	EIGEN KATHARINA ET AL: "Geometric modeling of the aortic inner and outer vessel wall from CTA for aortic dissection analysis", PROGRESS IN BIOMEDICAL OPTICS AND IMAGING, SPIE - INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING, BELLINGHAM, WA, US, vol. 10576, 13 March 2018 (2018-03-13), pages 105761X-105761X, XP060106805, ISSN: 1605-7422, DOI: 10.1117/12.2293096 ISBN: 978-1-5106-0027-0 * abstract; figures 2,5 * * section 2.3 *	6,7,16, 17	
A	US 2013/343622 A1 (RUIZ GUILLERMO [FR] ET AL) 26 December 2013 (2013-12-26) * paragraphs [0030], [0043] - [0049] *	1-20	TECHNICAL FIELDS SEARCHED (IPC) G06T

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 December 2023	Krawczyk, Grzegorz

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 5800

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	HEO RAN ET AL: "Optimal boundary detection method and window settings for coronary atherosclerotic plaque volume analysis in coronary computed tomography angiography: comparison with intravascular ultrasound", EUROPEAN RADIOLOGY, SPRINGER BERLIN HEIDELBERG, BERLIN/HEIDELBERG, vol. 26, no. 9, 2 December 2015 (2015-12-02), pages 3190-3198, XP036021650, ISSN: 0938-7994, DOI: 10.1007/S00330-015-4121-5 [retrieved on 2015-12-02] * section "Discussion", 2nd par.; page 3194 *	1-20	
			TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 December 2023	Krawczyk, Grzegorz

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 18 5800

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12-12-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010104160 A1	29-04-2010	CN 101622648 A	06-01-2010
		EP 2132715 A1	16-12-2009
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		WO 2008104897 A1	04-09-2008
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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